

CLAIMS

1. A piezoelectric element using a superhigh-oriented aluminum nitride thin film,

5                   the piezoelectric element being free from hillocks, cracks, and peeling and including a stack structure in which a bottom electrode, a piezoelectric body thin film, and a top electrode are sequentially formed on a substrate,

10                  the bottom electrode being made of an oriented W layer of which a (111) plane of W is parallel to a surface of the substrate, and

15                  the piezoelectric body thin film being formed of a c-axis-oriented aluminum nitride thin film having a rocking curve full width half maximum (RCFWHM) not exceeding 2.5°.

20                 2. The piezoelectric element using a superhigh-oriented aluminum nitride thin film as set forth in claim 1, wherein the substrate is a glass substrate.

25                 3. A piezoelectric element using a superhigh-oriented aluminum nitride thin film,

                    the piezoelectric element being free from hillocks, cracks, and peeling and including a stack structure in which a bottom electrode, a piezoelectric body thin film, and a top electrode are sequentially formed on a substrate, the bottom

electrode containing as a bottom layer an adhesive layer adhering to the substrate,

the bottom electrode being made of a stack body,

the stack body having a surface layer made of a metal  
5 layer having an electronegativity of around 1.4 and such an orientation that a crystal plane of a metal having an identical atomic configuration to an atomic configuration on a (001) plane of aluminum nitride and an almost equal atomic distance to an atomic distance on the (001) plane is parallel  
10 to a surface of the substrate, and

the piezoelectric body thin film being formed of a c-axis-oriented aluminum nitride thin film having a rocking curve full width half maximum (RCFWHM) not exceeding 2.5°.

15 4. The piezoelectric element using a superhigh-oriented aluminum nitride thin film as set forth in claim 3, wherein the substrate is a glass substrate.

20 5. A piezoelectric element using a superhigh-oriented aluminum nitride thin film,

the piezoelectric element being free from hillocks, cracks, and peeling and including a stack structure in which a bottom electrode, a piezoelectric body thin film, and a top electrode are sequentially formed on a substrate, the bottom  
25 electrode containing as a bottom layer an adhesive layer

adhering to the substrate,

the bottom electrode being made a stack body containing as a surface layer such an oriented W, Pt, Au, or Ag layer that a (111) plane of W, Pt, Au, or Ag is parallel to a surface of the  
5 substrate, and

the piezoelectric body thin film being formed of a c-axis-oriented aluminum nitride thin film having a rocking curve full width half maximum (RCFWHM) not exceeding 2.5°.

10 6. The piezoelectric element using a superhigh-oriented aluminum nitride thin film as set forth in claim 5, wherein the bottom electrode is made up of either two layers of Ti/Pt or Cr/Pt in accordance with a notation, "the first layer formed on the substrate/the second layer formed on the first layer" or three layers of Ti/Pt/Au, Ti/Ni/Au, or Cr/Ni/Au in accordance with a notation, "the first layer formed on the substrate/the second layer formed on the first layer/the third layer formed on the second layer."

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20 7. The piezoelectric element using a superhigh-oriented aluminum nitride thin film as set forth in claim 5, wherein the substrate is a glass substrate.

25 8. A method of manufacturing a piezoelectric element using a superhigh-oriented aluminum nitride thin film,

the method comprising the sequential steps of:

5 forming a bottom electrode on a substrate from such an oriented W layer that a (111) plane of W is parallel to a surface of the substrate by sputtering at a temperature from room temperature to a low temperature at which no spaces develop between W particles; and

10 forming a piezoelectric body thin film of a c-axis-oriented aluminum nitride thin film having a rocking curve full width half maximum (RCFWHM) not exceeding 2.5° on the bottom electrode; and

forming a top electrode on the piezoelectric body thin film.

15 9. The method of manufacturing a piezoelectric element using a superhigh-oriented aluminum nitride thin film as set forth in claim 9, wherein the substrate is a glass substrate.

20 10. The method of manufacturing a piezoelectric element using a superhigh-oriented aluminum nitride thin film as set forth in claim 9, wherein the bottom electrode is deposited by r.f. plasma-assisted sputtering.

11. A method of manufacturing a piezoelectric element using a superhigh-oriented aluminum nitride thin film,

25 the method comprising the sequential steps of:

in forming, on a substrate, a bottom electrode of a two-  
or more-layered stack structure including an adhesive layer  
adhering to the substrate, firstly depositing the adhesive  
layer by sputtering at a temperature from room temperature  
5 to a low temperature at which no spaces develop between  
particles and then depositing as a surface layer of the bottom  
electrode a metal layer by sputtering at a temperature from  
room temperature to a low temperature at which no spaces  
develop between particles so that the metal layer exhibits  
10 such orientation that a crystal plane of a metal is parallel to  
a surface of the substrate, by using such a metal having an  
electronegativity of around 1.4 that a crystal plane of the  
metal has an identical atomic configuration to an atomic  
configuration on a (001) plane of aluminum nitride and an  
almost equal atomic distance to an atomic distance on the  
15 (001) plane;

forming a piezoelectric body thin film of a  
c-axis-oriented aluminum nitride thin film having a rocking  
curve full width half maximum (RCFWHM) not exceeding 2.5°  
20 on the bottom electrode; and

forming a top electrode on the piezoelectric body thin  
film.

25 12. The method of manufacturing a piezoelectric element  
using a superhigh-oriented aluminum nitride thin film as set

forth in claim 11, wherein the substrate is a glass substrate.

13. The method of manufacturing a piezoelectric element using a superhigh-oriented aluminum nitride thin film as set forth in claim 11, wherein the bottom electrode is deposited by r.f. plasma-assisted sputtering.

14. A method of manufacturing a piezoelectric element using a superhigh-oriented aluminum nitride thin film,

10           the method comprising the sequential steps of:

      in forming, on a substrate, a bottom electrode of a two- or more-layered stack structure including an adhesive layer adhering to the substrate, firstly depositing the adhesive layer by sputtering at a temperature from room temperature to a low temperature at which no spaces develop between particles and then depositing as a surface layer an oriented W, Pt, Au, or Ag layer that a (111) plane of W, Pt, Au, or Ag is parallel to a surface of the substrate by sputtering at a temperature from room temperature to a low temperature at 15 which no spaces develop between particles;

      forming a piezoelectric body thin film of a c-axis-oriented aluminum nitride thin film having a rocking curve full width half maximum (RCFWHM) not exceeding 2.5° on the bottom electrode; and

25           forming a top electrode on the piezoelectric body thin

film.

15. The method of manufacturing a piezoelectric element  
using a superhigh-oriented aluminum nitride thin film as set  
forth in claim 14, wherein the substrate is a glass substrate.  
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16. The method of manufacturing a piezoelectric element  
using a superhigh-oriented aluminum nitride thin film as set  
forth in claim 14, wherein the bottom electrode is deposited  
10 by r.f. plasma-assisted sputtering.

17. A piezoelectric element using a superhigh-oriented  
aluminum nitride thin film,

the piezoelectric element including a bottom electrode, a  
15 piezoelectric body thin film of aluminum nitride, and a top  
electrode stacked in this order on a substrate; and

the aluminum nitride having a rocking curve (RCFWHM)  
not exceeding 2.5°.

20 18. The piezoelectric element using a superhigh-oriented  
aluminum nitride thin film as set forth in claim 17, wherein  
the bottom electrode is either a single, metal layer or a stack  
body including an adhesive layer adhering to the substrate  
and one or more metal layers on the adhesive layer.

19. The piezoelectric element using a superhigh-oriented aluminum nitride thin film as set forth in claim 18, wherein the stack body has a surface layer made of a metal having an electronegativity between 1.3 and 1.5 inclusive.

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20. The piezoelectric element using a superhigh-oriented aluminum nitride thin film as set forth in claim 18, wherein the stack body has a surface layer made of a metal having a crystal plane having an identical atomic configuration to an atomic configuration on a (001) plane of aluminum nitride and an almost equal atomic distance to an atomic distance on the (001) plane.

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21. The piezoelectric element using a superhigh-oriented aluminum nitride thin film as set forth in claim 18, wherein the stack body has as a surface layer an oriented W, Pt, Au, or Ag layer that a (111) plane of W, Pt, Au, or Ag is parallel to a surface of the substrate.

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20. The piezoelectric element using a superhigh-oriented aluminum nitride thin film as set forth in claim 18, wherein the stack body is made up of either two layers of Ti/Pt or Cr/Pt in accordance with a notation, "the first layer formed on the substrate/the second layer formed on the first layer" or three layers of Ti/Pt/Au, Ti/Ni/Au, or Cr/Ni/Au in

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accordance with a notation, "the first layer formed on the substrate/the second layer formed on the first layer/the third layer formed on the second layer."

5       23. The piezoelectric element using a superhigh-oriented aluminum nitride thin film as set forth in claim 17, wherein the substrate is a glass substrate.